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Summaries of Addresses of Presidents of Sections.

MATHEMATICAL AND PHYSICAL SCIENCES.

President: Dr. C. G. DARWIN, F.R.S.

LOGIC AND PROBABILITY IN PHYSICS.

RECENT scientific history has revealed a deep schism between the professional philosophers and the scientists, and this schism is worthy of examination. Prof. Darwin, therefore, deals with the wide theme of the philosophy of physics.

Prof. Darwin develops the idea that the old logic was devised for a world that was thought to have hard outlines and that, now that the new mechanics has shown that the outlines are not hard, the method of reasoning must be changed. The key to this is the principle of probability, but whereas in the past, attempts were made to fit this into the old system, the new mechanics suggests the possibility of a different synthesis.

The really live branches of physics call for a very different kind of thought from the old formal logic; in fact, outside pure mathematics any subject is apt to become dead and uninteresting as soon as it is brought down to this form. Axioms are not really the most important things, but it is the whole body of accumulated doctrine that matters. Also the idea of a " crucial " experiment believed in by the ' logic ' school has not much force, since it is the cumulation of a number of pieces of evidence and not one of the pieces that makes us believe in a physical theory—for example, relativity. An axiomatic basis is too narrow for the understanding of the physical world.

Something wider is needed, a wider system of logic which has probability for one of its features, but there does not seem to be much use in trying to bring probability into the narrow fold of the old logic. A review of recent history of atomic theory has shown clearly that the prejudice against probability and in favour of causality is wrong for a reason never previously thought of. This theory revealed two mutually contradictory but both indubitable pieces of evidence, and in the dynamic period of its development, Bohr and other leaders recognised the difficulties on both sides but maintained an attitude of balance hoping for the coming of a higher synthesis. Quantum theory grew stronger and stronger, and finally the New Quantum Theory burst forth placing in the hands of the mathematicians the wave function, the most powerful of weapons for the technical discussion of atomic problems. It was however the Uncertainty Principle that showed up a fallacy in the old argument about causality. It is now easy to see that there was nothing wrong in the old inference that the future could be forecasted exactly if we know all about the present; but the trouble was the impossibility of knowing the present.

One of the most convincing ways of seeing that probability cannot be brought within the fold of formal logic is the kinetic theory of gases. The greatest contribution to this subject was that of Gibbs who introduced the notion of ensemble, and canonical ensembles. The principle of probability embodied in the averaging over the ensemble was frankly laid on the top of the logical principles of Newtonian mechanics, but it is now found that the new mechanics accommodates it much more easily and can be united with it in a higher synthesis. Another idea developed in Gibbs' work, that of the grand ensemble has not yet been incorporated in the new physics, and one may venture to forecast that when some of our present difficulties in the quantum theory are cleared up, it will be found that we shall be using the notion of the grand ensemble. A real and full synthesis is still to be made and when this is made we may hope to have something that has no indefinite outlines, *i.e.*, a new and reformed principle of reasoning.

The subject of probability ought to play an enormously greater part in our mathematical-physical education, and its elements should form part of a general education also. Mathematicians are still so interested in the study of rigorous proof that all the emphasis goes against the study of probability. It may however be said that it is not special new courses that are needed, but rather a change in the spirit of our old courses, by the incorporation of probability in other subjects.

If these reforms are carried out, it may be hoped generations will grow up which have a facility in thinking about the world in the way which quantum theory has shown to be the true one. Inaccuracy in the world will not be associated with inaccuracy of thought and the result will ultimately be a fuller and better understanding of the basis of natural philosophy.

B. S. MADHAVA RAO.

CHEMISTRY.

President: PROF. CHARLES S. GIBSON, O.B.E., M.A., SC.D., F.R.S.

RECENT INVESTIGATIONS IN THE CHEMISTRY OF GOLD.

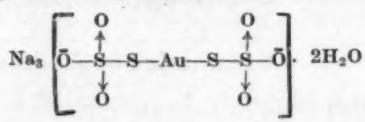
THE address commences with a discussion of the evidence concerning the multivalency of copper, silver and gold, by a study of some of their important compounds. It is pointed out that the univalency and bivalency of copper and silver are well established and that the tervalency of silver is still a doubtful matter. Modern investigations have shown that gold differs from copper and silver in that it exists only in the univalent and tervalent conditions and that it is extremely unlikely that it ever exists in the bivalent condition.

Recently, chemical evidence has indicated that cuprous halides, silver halides and aurous halides have the general formula :

where X = halogen, indicating the 2-covalency of cuprous copper, argentous silver and aurous gold in these compounds.

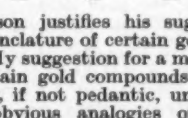
Bassett and Corbet (1924) proved by a phase-rule study of the complex cyanides of copper, silver and gold that cuprous copper and argentous silver can exhibit 2- and 4-covalency wheras aurous gold showed a co-ordination number of only 2. Mann, Wells and Purdie also (1936 and 1937) came to the same conclusion after a study of the trialkylphosphine and trialkylarsine derivatives of cuprous, silver and aurous halides.

" Much of the confusion of knowledge regarding the chemistry of gold as described in almost all text-books and more comprehensive works arises from the fact that the simple halide and cyanogen derivatives are regarded as normal metallic salts and given the formulæ AuCl, AuBr, AuI, AuCN, $AuCl_3$, $AuBr_3$ according to the fundamental uni- or tervalency of the metal. This is all the more surprising in view of the long-established and well-known fact that whenever gold is in solution or in the form of a soluble salt it is always present as a complex. There is only need to mention as examples potassium aurocyanide, probably—on account of its application in the metallurgy of gold—the most completely investigated derivative of the metal and the very interesting sodium aurothiosulphate prepared as long ago as 1845 by Fordos and Gelis. Even at the time of its discovery, this latter compound was known to give neither the usual reactions for gold nor the usual reactions of a thiosulphate. It has long been used for fixing and toning silver photographic prints. Since its introduction in 1924 by the Danish physician, Möllgaard, for the treatment of tuberculosis and, later by others for the treatment of rheumatoid arthritis, it has been considerably investigated and has formed the basis of the modern ' gold therapy '. Curiously enough, in a standard text-book published as recently as 1937, the formula, $Au_2S_2O_3 . 3 Na_2S_2O_3 . xH_2O$ seems to be preferred to the correct $Na_3 Au(S_2O_3)_2 2 H_2O$ which may be fully written



in which, of course, the aurous gold atom is 2-covalent, the compound being of the same type as the well-known potassium aurocyanide, K [N ≡ C − Au − C ≡ N], already mentioned."

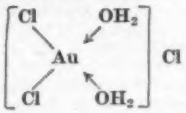
The best known auric compounds are the halogenoaurates. Some of the recently investigated compounds of this type are hydronitratoauric acid, hydrodisuccinimidochloroauric acid, hydrodiphthalimidohydroxyauric acid, and hydrodimethylglyoximinylbromoauric acid. All the above compounds contain the 4-covalent auric gold atom. Auric chloride (trichlorogold) or auric bromide can be adequately represented by the formula :



(X = Cl, Br)

Professor Gibson justifies his suggestion for a modified nomenclature of certain gold compounds as follows : " My suggestion for a modified nomenclature of certain gold compounds may be criticised as being, if not pedantic, unnecessary. It arises from obvious analogies of the organic compounds of gold with similarly constituted inorganic compounds of the metal ; its only object is to avoid further confusion in the chemistry of gold. Such confusion is constantly occurring. At the present time, in books of reference and even in original literature ' auric chloride ' may imply hydrochloroauric acid in the presence or absence of hydrochloric acid, or it may imply a neutral salt—generally the sodium salt—of hydrochloroauric acid and, much less frequently gold trichloride or—to alter its name more profoundly in order to indicate that the compound is not a salt—trichlorogold. As a result of this confusion the statement is repeatedly found in the literature that ' auric chloride is soluble in ether '. If this statement refers to the pure compound having the molecular formula $(AuCl_3)_2$, it is not true. Hydrochloroauric acid and hydrobromoauric acid containing water of crystallisation, the compounds $HAuX_4 . 3 H_2O$, are soluble in ether but they are insoluble when anhydrous. Although the fact

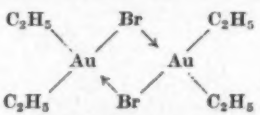
was known long before, the definite statement that gold chloride is soluble in ether appears to be due to Willstätter (1905); but it is clear that the material he was investigating was not $(AuCl_3)_2$, but an aqueous solution of hydrochloroauric acid which he termed gold chloride; and, as a result, the above erroneous statement is still in text-books published as recently as 1937. The hygroscopic nature and solubility of 'auric chloride', *i.e.*, gold trichloride, in water is not due to the solubility of the compound *per se*, but to the formation in the first place of a compound diaquodichloroauric chloride,



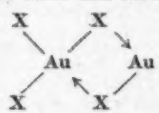
a type of co-ordinated auric gold salt, frequently met with in the present series of investigations, which is soluble in water and undergoes further changes in that medium resulting in the formation of hydrochloroauric acid and aurous chloride (monochlorogold).

The following is a short account of the researches on the chemistry of gold carried out by Prof. Gibson and his collaborators:

(*a*) *Dialkyl halogeno compounds* (Pope and Gibson, 1907; Gibson and Simonsen, 1930, and Gibson and Colles, 1931). Gibson and Pope prepared in 1907 the first organic gold compound then styled diethylauric bromide. This work was greatly extended by the work of Gibson and Simonsen (1930) and Gibson and Colles (1931). The typical compound of this series diethylmonobromogold has the formula:

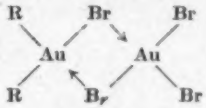


The other compounds prepared include amminodiethylbromogold, pyridinodiethylbromogold, and dibenzylsulphidodiethylbromogold. Acetylacetonediethylgold was the first organic gold compound containing no halogen to be prepared and from which brilliant gold films could be obtained. Derivatives containing ethylenediamine similar to the above-mentioned ammino and pyridino derivatives were also obtained and one of the monoethylenediaminotetra-*n*-propyldibromodigold (Burawoy and Gibson, 1934) was found to yield the salt ethylenediaminodi-*n*-propylgold bromide. Decomposition of such compounds in which two 4-covalent auric gold atoms were present in the molecule resulted in a mixed auric-aurous compound in which the gold atoms were 4-covalent and 2-covalent respectively. This suggests that such halides as Au_2X_4 (formerly written as AuX_2) would be mixed auric and aurous compounds as



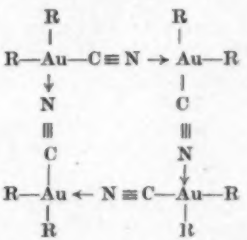
and that they might be formed as intermediate products in the decomposition of the trihalides to the monohalides.

(*b*) *Monoalkyldibromo compounds* (Pope and Gibson, 1907; Burawoy and Gibson, 1934 and 1935).—The monoethyl and mono-*n*-propyldibromoauric compounds have been studied in some detail and their constitution is represented thus:



These compounds decompose slowly yielding alkylbromide and gold monobromide. Chemically the monoalkyldibromogold compounds behave as equimolecular mixtures of gold tribromide and the dialkylmonobromogold.

(*c*) *Cyano derivatives of organic gold compounds* (Gibson, Burawoy and Holt, 1935; Burawoy, Gibson, Hampson and Powell, 1937).—The dialkylmonocyanogold compounds differ from those previously described in that they contain four atoms of tervalent gold in the molecule. They have a symmetrical twelve-atom planar ring structure.



The dialkyldicyanodigold compounds are very sparingly soluble in organic solvents and they constitute further examples of mixed 4-covalent auric and 2-covalent aurous compounds.

The decomposition of these compounds furnished several facts of great interest, *e.g.*, *n*-hexane was obtained for the first time by the decomposition of a *n*-propyl compound.

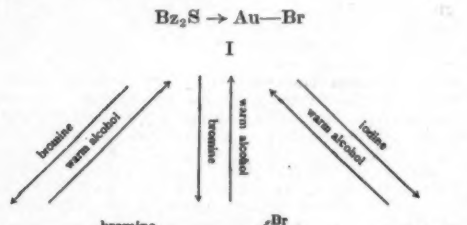
(*d*) *The structure of gold compounds.*—Our knowledge of the structure of various types of gold compounds has been enriched as a result of X-ray crystallographic investigations of Powell (1937) at Oxford, Wells (1936) at Cambridge, and Cox and Webster (1936) at Birmingham. The planar configuration of the four valencies of tervalent gold and the linear configuration of the two valencies of aurous gold are now firmly established. The X-ray investigation of diethylmonobromogold by Powell showed that two gold atoms and two bromine atoms lie close together near the origin and that the molecule is $Au_2(C_2H_5)_4Br_2$. These four atoms form a rough square in a plane somewhat inclined to (001). The molecule projected on the plane of the gold and bromine atoms is shown below. The carbon atoms marked ⊕ and

⊖ are respectively above and below the plane of the other atoms.

The planar and symmetrical distribution of the four valencies of tervalent gold in a non-electrolyte thus confirmed the same results obtained by Cox and Webster in the case of the salt, potassium bromoaurate $KAuBr_4 \cdot 2\,H_2O$.

Powell and Phillips have also completed the X-ray study of di-*n*-proplymonocyanogold $(Pr_2\,AuCN)_4$. They have discovered (1) association of four gold atoms in one molecule, (2) existence of the group $Au - C \equiv N \rightarrow Au$ and (3) direct linking of two propyl groups to the gold atoms. The shape of the molecule approximates to a square and the distance $Au - C \equiv N \rightarrow Au$ is the same for each side and equal to 5·18 A, which is in agreement with the value 5·28 A for the length of the group $Au - C \equiv N \rightarrow Au$ as derived from the available data on bond lengths.

(*e*) One of the studies of gold derivatives of organic sulphur compounds involved the reactions which are outlined below.



The colourless 2-covalent aurous compound (I) (dibenzylsulphidomonobromogold) and the deep red 4-covalent auric compound (II), (dibenzylsulphidotribromogold) have no unusual properties. But substances (III) and (IV) present interesting features from the structural point of view. Our knowledge of the physical and chemical properties of these substances is too meagre for determining the constitution of the substances in the solid state. Careful crystallographic and X-ray analysis is the only method of determining the constitution of such compounds, and it may be that such investigations will give useful information about ' complex molecules ' generally.

K. R. KRISHNASWAMI.

GEOLOGY.

President: PROF. H. H. SWINNERTON, D.Sc.

DEVELOPMENT AND EVOLUTION.

IN his Presidential Address to the Section of Geology, Prof. H. H. Swinnerton deals with the relationship between " Development and Evolution ". Starting from the earlier general conception of Von Baer and Hæckel of 'ontogeny' being a repetition of 'phylogeny', Prof. Swinnerton soon proceeds to point out that there is a fundamental difference between the views of these two great workers, which it is necessary to clearly appreciate. Whereas Von Baer and his followers propounded the view that "the young stages in the development of an animal are not like the adult stages of the other animals lower down the scale but are like the young stages of those animals " the followers of Hæckel maintained that " the adult stages of the ancestors are repeated during the development of the descendants, but are crowded back into the earlier stages of Ontogeny, therefore making the latter an abbreviated repetition of Phylogeny ". The study of fossils, especially the invertebrates, seemed to reveal an increasing body of facts in support of Hæckel's theory, while the study of living forms did not lend support to this principle—Garstang expressing the opinion so recently as 1929 that " the theory of adult recapitulation is dead, and need no longer limit and warp us in the study of Phylogeny ". It will, however, be seen that the idea of 'recapitulation ' in the sense of summing up, is inherent in both Von Baer's and Hæckel's theories but the fundamental difference is that while for the former it is a recapitulation of *juvenile* conditions, for the latter, it is a recapitulation of *adult* conditions. The main point at issue therefore is whether or no *adult* recapitulation, either specific or general, does occur. It is on this point that there is a striking divergence of opinion between biologists on the one side and invertebrate palæontologists on the other. As Prof. Swinnerton points out " the fact that in matters of this kind, serious workers can hold such diverse views indicates the possibility that Nature's methods are equally diverse. "

With this introduction, Prof. Swinnerton proceeds to consider the present position on this matter approaching the subject from the palæontological side, and points out that any consideration of the relationship of development to evolution must deal with the subject from two aspects—the *retrospective* and the *prospective*. "On the one hand, we must inquire whether the evolutionary changes of the past are reflected in development, and if so, to what extent. On the other hand it must also inquire whether future evolutionary changes of sudden or of sequential character are foreshadowed in development. " It is obvious that these two

aspects are closely interwoven with one another and as Prof. Swinnerton points out, much confusion has crept into recent discussions of this subject due to a want of appreciation of their fundamental distinctness. Prof. Swinnerton also finds it necessary to clearly define the terms used in connection with these studies, so as to eliminate the possibility of confusion due to diversity in the shades of meaning attached to them.

Under the 'retrospective' aspect, Prof. Swinnerton refers to the classical work done by Carruthers on *Zaphrentis delanouei* and points out its great importance in the study of recapitulation. Examples have also been given from other groups of animals whose development has been studied in great detail in recent years, *e.g.*, the Orbitoides group among the Foraminifers, the gens *Gryphea incurva* among the Lamellibranchs and *Spirifer* among the Brachiopods. Under the 'prospective' aspect, Prof. Swinnerton discusses the importance of various phenomena such as Cœnogenesis (the appearance of new characters at an early stage of development), Proterogenesis (the extension of new characters from early to late stages of development), Deuterogenesis and Tachygenesis (the appearance of new characters at the latest stage in development and their extension to earlier stages), and Mutation; and in each case, refers to the evidence afforded by studies in different groups.

The address is a masterly review of recent work dealing with an important and fascinating aspect of the study of Evolution. L.R.R.

ZOOLOGY.

President: Dr. Stanley Kemp, Sc.D., F.R.S.

OCEANOGRAPHY AND THE FLUCTUATIONS IN THE ABUNDANCE OF MARINE ANIMALS.

THE term Oceanography should not be used in the restricted sense to mean hydrography or the physics and chemistry of seawater. It is much more comprehensive, and includes not only the physico-chemical work, coastal surveys, studies of tides and currents but also marine zoology, botany and parts of geology and meteorology. Great advances have been made in the study of the subject since the establishment of the Marine Biological Station 70 years ago at Naples. Several expeditions such as the 'Challenger' have been fitted out, and we have been made acquainted with oceanic and abyssal faunas and with the hydrography of ocean basins. Other aspects of study which could not be carried out by such expeditions have been taken up in marine biological stations, several of which have been established both in Europe and in America. A stage is now reached when a well-equipped tropical station in the Indo-Pacific region is urgently needed. State Fisheries Laboratories have contributed very largely to the study of Oceanography. Almost complete accounts of the natural history of a number of fish have been published. By this means fundamental knowledge that is necessary in the solution of several fisheries problems has been acquired. Progress in Oceanography has thus been due to the early expeditions, marine biological stations and fisheries departments. Zoological physiologists have added greatly to a correct appreciation of function in marine animals and life-histories of large numbers of animals have been studied with accuracy.

Years of study have convinced us that there are annual fluctuations in the abundance of fish, dependent on the events connected with their developmental stages. These fluctuations may be different in their intensity in different parts of the coast. Though much valuable information in this connection has been collected by the International Council for the Exploration of the Sea, still the precise reasons for good and bad spawning seasons in several cases yet remain obscure. In addition to these annual fluctuations there are what are known as long-period fluctuations which become superposed upon the normal annual fluctuations. Russel's work on the young fish obtained in the Plankton at Plymouth for the past 13 years throws a flood of light on the long-period fluctuations. There has been a decrease in recent years in the amount of larval fish of both summer and spring spawning forms occurring along the Plymouth coast. The Plymouth Herring Fishery also has declined very considerably recently. Studies by Ford at the Plymouth Marine Laboratory have shown that the abundant catches of 1924–25, 1927–28 and 1929–30 are to be regarded as normal annual fluctuations due to the great abundance of the 5-year old fish. But this abundance was not replaced by adequate numbers of younger fish in later years and the fishery has been greatly affected. This depression in the Plymouth area may be correlated with the lessening amount of phosphates in the sea-water on the Plymouth coast which has become increasingly evident from the year 1931 as shown by Dr. Atkins. The renewal of the phosphates in the channel is dependent largely on the inflow of Atlantic waters. It is likely that the reduction in the phosphates is to be traced to the changes undergone by the normal water movements off the mouth of the channel. That such changes do take place has been shown by the discovery of Russel who regards species of Sagitta as indicators of water movements. The 94 per cent. of *Sagitta elegans* and the 6 per cent. of *Sagitta setosa* in his tow-net hauls of 1930 became changed into 17 per cent. for *Sagitta elegans* and 83 per cent. for *Sagitta setosa* in the next year when the deficiency of phosphates and the decrease in numbers of summer spawning fish first became evident.

The next part of the address is devoted to a consideration of the changes which affect the biological condition of the water and it is suggested that the causes for these long-period fluctuations may not be same everywhere but may be brought about by slightly different factors in different places. A thorough investigation of the ocean movements in the Atlantic spread over a period of several years alone can make clear

what at present remains very largely obscure. These problems are receiving increasing attention in Europe and in America. Speaking of the fishery work done in the British Empire, Kemp is profoundly dissatisfied. In South Africa and in India with immense possibilities for fisheries development, facilities for work are very inadequate. There is a lack of fundamental knowledge that is so essential to future work in Fisheries. In India Japanese trawlers are taking full advantage of the situation and are exploiting the Bay of Bengal in ever-increasing numbers. Only by systematic and strenuous work continued over several years can the basic knowledge that is necessary for the solution of important fisheries problems be obtained. To this aspect of work more and more attention must be paid throughout the British Empire and the address concludes with a fervent hope that " when, in God's good time, the nations begin to turn their armaments to better uses, and the mass production of ploughshares begins.. it will not be forgotten that there is also a harvest of the sea." R.G.I.

GEOGRAPHY.

President : PROF. GRIFFITH TAYLOR.

CORRELATIONS AND CULTURE.

A Study in Technique.

"CORRELATIONS AND CULTURE," formed the topic of the presidential address of Prof. Griffith Taylor, to the Geography Section of the British Association for the Advancement of Science, held this year at Cambridge. Suggesting the definite need for geographical studies and mapping of geographical data in any valid interpretation of the concept of culture, the address is dealt with under three main divisions. In the first, is considered the field of Cultural Geography ; in the second, is discussed a technique found very useful in research in that subject ; and in the third, is suggested the modifications, in the aspects of culture, necessary in a modern general education.

Geography is defined as " the science concerned with description, localisation and explanation of data which relate man to his material environment ", and its essential feature is indicated to be the localisation of data (*i.e.*, the charting of data in question) with a view to explaining their distribution. The close relation of geographic studies to both physical and social sciences is emphasised and the way in which geography links the four *Environmental* Sciences of Geology, Physics, Astronomy and Botany with the four *Human* Sciences of History, Anthropology, Sociology and Philology is indicated. Students of History are apt to belittle the value of geographic data in investigating their problems, which should not be the case. The charting of geographic data is helpful to social sciences, and the aid which geographers can give to historians is illustratd by examples from the Weald and from the Blue grass country of Kentucky. In both these areas, the characteristic cultural development is shown to be primarily dependent on conditions of geological structure. The use of *isopleths* (lines of equal abundance) in interpreting the essential features of the renaissance is clearly pointed out. There is doubtless an inherent disadvantage in geography in the large number of facts to be assimilated in its study, but it is pointed out that memorising facts need never be a vital factor in geography and that students in Cultural Geography should learn to doubt and deduce rather than memorise the innumerable facts presented without co-ordination.

In the second section, which forms the main purpose of the address, is shown by numerous illustrations, that by careful mapping of the distribution of several Culture-facts and correlating them, the investigator can deduce the cradle land of various cultures and the order of their evolution. Cultural evolutions, like biological, are responses to environment, though considerably more rapid. The ' zones and strata ' concept of the geologists and biologists, adopted in their field of research on biological evolutions, is pressed into service to deduce the various culture spreads. This theory, in brief, premises that, primitive races, culture, religion, etc., evolved as a response to environment in a common cradle land, migrate and spread outwards giving place to others which may arise there later ; and consequently, primitive cultures do not belong to places where they are now seen but have migrated there, from their places of origin. From an extensive study it is inferred that Central Asia has been the most appropriate environment for the racial and cultural evolutions : and it is put forth that the primitive races, languages, cultures and religions were all evolved in that cradle land and spread outwards to different continents in the efflux of time.

Prof. Griffith Taylor believes that the primitive man was differentiated into the five major races long before the later races reached Western Europe, and that this evolution took place in Central Asia. Consequently he holds that the negroes and negritoes also, evolved in the common cradle land of Central Asia and not in Africa as held by others. Based on the inference of geographic conditions which existed in early times, the migration of races from the common cradle land to different parts of the world, along suitable corridors, is then described ; and it is shown that all the present progressive nations of the world are built up of the same three stocks, ' Alpine, Nordic and Mediterranean '. It is held that cultural differences could be easily bridged over and assimilated ; but a race barrier, such as that which exists between the earlier evolved negro stock and the later evolved stocks, cannot be so readily adjusted.

The actual difference between race and culture is then discussed. Difference of culture is shown to have no bearing on racial differences. For instance, the Jews have a different culture, language and religion but they are composed of the same races as the other European nations. To express such groups linked purely by cultural characters, the extension of application of the

word 'Cult' is advocated. It is not correct to say that there is a Jewish race in Europe, or a French race in Canada, but it is logical to talk of a Jewish or French Cult.

The 'Zones and Strata' concept has next been applied to trace the linguistic relationships, and it seems to offer clues as to the relationship between the Aryan, Basque, Altaic and other groups. It is believed that the Aryan languages originated from near Turkestan and spread outwards from there. It is doubtful who first spoke the Aryan language, but from the 'zones and strata' theory it is deduced that the Nordic races, however, did not speak originally this language, but spoke Finnish or some other allied non-Aryan language. The growth and spreading of several cultures are next discussed in the same way, by the application of the technique of the zones and strata concept.

Prof. Griffith Taylor classifies the geographers into three groups: theocratic, geocratic or environmental, and possibilist. He believes in the environmental control or 'Stop and Go Determinism', differing in this respect from the orthodox views of many historians and geographers.

In the final section, a plea is put forth for a drastic revision of the programme for a general cultural education. The cutting down of the study of classical languages like Latin and Greek, and giving greater attention to Biology which deals with the evolution of man as an animal. History which deals largely with the growth of his ideals and institutions, and thirdly Geography which deals with his present, often varying, environment are stated to be necessary. It is considered desirable to swing the attention of youth, for a generation or two, from the problems of Physical Science to the more difficult and dangerous problems of Social Science. There is no risk to day, as it was in the past, in stating that the earth is round, revolves round the sun, and is of small importance in the Cosmos. But there is grave danger, in many circles in stating the truth about Communism, Socialism, etc., which conflict with established interests. These creeds are cultural facts and they are today more vital to the man of culture than is the well recognised and valuable culture based on art, music, or classics. Therefore, the student of Cultural Geography can feel certain that he is working right on the forefront, in man's progress towards a higher type of civilisation.

B. R. R.

ECONOMICS.

President: R. F. HARROD.

SCOPE AND METHOD OF ECONOMICS.

ENCOURAGED by the recent outcrop of speculation upon the methodology of economics, Mr. Harrod felt an 'inner urge' to say something on it. The pure theory of classical economics may be divided into (1) the theory of value and distribution and (2) the maxim that productive resources should be so distributed among occupations as to yield an equimarginal social net product. The first professes ability to deduce from given circumstances general laws of rigid demonstrability and certainty concerning the casual succession of events having an empirical basis. These laws are deducible from the law of diminishing utility or law of demand, an axiom of the highest possible degree of empirical probability. But the degree of its generality is so great as to render the power of prediction almost nugatory. Recent attempts of economists to get greater knowledge of causal sequences than is vouchsafed by the law of demand (*e.g.*, trade cycle theories) have led to the undesirable results of making economics conjectural. Having said so much as introduction, Mr. Harrod proceeds to deal with the subject under four heads.

1. *The Economic Criterion.*—First about the choice of the criterion itself. Critics like Robbins say that the economist must only state the sequences of events, but not offer advice. This view claims both too much and too little; too much because it gives an exaggerated idea of the economist's power of prediction at the present juncture, and too little, because it claims that his advisory power is confined within the narrow limit of his predictory power. Any definition of the economist's advisory rôle which does not realise the value of his references to the analytical map is unrealistic and fails to do justice to the usefulness of the economist. Even when a specific end is furnished to him he has to employ his own criterion. Next, the criterion must be tested in the real world. The construction of a realistic map involves important analytical work in the form of propositions *re* the equality of price to the sums of rewards of agents contributing to production, etc. Economists of the past were too hasty in assuming exact correspondence between the facts of real life and those of the map, and exalted the principle of *laissez faire*. A large part of Pigou's welfare economics, as well as recent theories of imperfect competition, try to recommend interferences to make it correspond to the map.

2. *General Theory of Value and Distribution.*—How is the Law of Demand derived? Not from the markets in the ordinary sense or from the psycho-physiological principle; but it is an *a priori* axiom derived from that homogeneity and heterogeneity together resident in exchangeable object, and is seen by observation, introspection and assumption. The predictory power cannot go far, in the absence of more precise quantitative knowledge. But is this the centre of economics? It seems that the predictory power cannot be enlarged further from the value theory, and that more specific laws would have to be based on detailed empirical work and would be highly conjectural. But if it is not to be the main avenue for future developments, then the general theory of value must itself be displaced from its central position.

3. *Dynamic Economics.*—Out of the wide field of possibilities for quest for causal laws outside the law of demand, the first for consideration is dynamic economics. There ought to

be alongside of the static theory a body of laws relating to the increase of economic magnitudes, to be constructed with the aid of a few empirical generalisations. New formulations are to be made regarding the movement of economic magnitudes under the influence of growth of population, savings, inventions, etc., on simplifying assumptions like frictionless surface, etc. The concept of motion under the influence of steadily operating forces attained in the form of a few basic empirical laws of wide generality, may yield, in connection with the study of mutual implications, an elaborate structure of deductive theory. An instance of it is the proposition that of Keynes, that at a given rate of interest people will save a larger absolute amount from a larger income.

4. *Empirical Studies.*—Causal laws must be supported by empirical evidence, must be mutually consistent and must use the analytical map. The work consists of the collection of new statistical material and also the application of the statistical technique. The objection to the more deductive method is that a crucial experiment is impossible, and it is difficult to test hypotheses by the collected data of observation. This strengthens the case for refined statistical treatment of observed facts. (However, Mr. Harrod has many points against the 'laments' of Mrs. Wootton.)

" I believe that we may be on the eve of a great advance in economic theory, taking us right outside the ambit of the static system of equations. The wealth of statistical data, together with the indications resident in the trade cycle that the succession of events is governed by laws still undiscovered, should be a spur to the inventiveness and enthusiasm of every student....any day he may light upon some general relation of wide validity satisfying to the intellect and capable of yielding vast benefit to humanity..... The task of the economist is rendered arduous by the intractable nature of the phenomena which he has to study; but he is better placed than other social students, and if he turns a deaf-ear to cavillers, the past achievements of his subject and its present vitality may buoy him up with a reasonable hope ". Thus concludes this weighty address.

P.J.T.

ENGINEERING.

President: PROF. R. V. SOUTHWELL, F.R.S.

THE CHANGING OUTLOOK OF ENGINEERING SCIENCE.

AS engineering knowledge and the requirements of industry are rapidly changing, planning of engineering education is necessary. Practical and academic sides of engineering should be regarded as one undivided whole. Engineering science is defined as the academic aspect of engineering and the author discusses it under three heads.

1. TEACHING.

Industrialists have lost their old time contempt for the engineering graduate but the qualities demanded now are new. The college curriculum tends to overcrowding, each enthusiast desiring to include a little more of his subject. The final result is a syllabus which the average student cannot assimilate. The industrialist now engages specialists for his special problems and demands from the graduate ability to take wide views, to think, to negotiate and to control; qualities which can be developed only in their undergraduate years given sufficient leisure for original thinking. The knowledge of engineering principles required is such as an average student should be able to acquire and can be tested by easy papers. The time table should not therefore be overcrowded. There is however need to co-ordinate the three years' college instruction with the two years practical training so as to form a connected five years' training carried out with a single objective.

2. RESEARCH.

Engineering research has become specialised and a tendency is observed to leave everything to the pure scientist. The attitude of the engineer to his problems is however entirely different from that of the pure scientist. The latter requires ideal conditions and materials. He is free to choose his path or alter it at his will. His shapes are not dictated by constructional or manufacturing requirements; nor his materials by considerations of strength or cost. The engineer, on the other hand, has to solve a problem as it is presented and some solution he must have even though it is only approximate. Engineering research requires the gift of visualisation and this must be fostered deliberately. The inevitable factor of safety must be reduced as improved methods are evolved. Owing to a margin of error being ever present in the engineer's data, he cannot copy exactly the scientist's methods, but must develop a method of his own. The "Relaxation method" devised by the author has been able to solve many problems hitherto regarded as difficult. It is not to be imagined that engineering does not aim at accurate calculations. On the contrary, correct calculations are more important for them as the real check, *viz.*, test to destruction, is both costly and dangerous. Engineering research should aim to point out the " disturbing factors" in the scientist's solutions and to leave the scientists to solve the new problems thus presented.

3. RELATIONS TO COMMUNITY.

The accusation is sometimes levelled against scientists and engineers that they are responsible for the modern wars and their horrors. This is entirely groundless. Wars have always been made by communities and not by engineers; nor is the horror peculiar to modern wars. By their search for knowledge, scientists and engineers have opened up vast sources of power. Knowledge is non-moral. Poisons and deadly weapons may be used for the happiness of a community in preventing disease, etc. It is

not the fault of the scientist if these powers are used for evil objects. The engineer has been silent in the past. As a member of the community he has a duty to perform. He can instil into the mind of the public a clearer notion of the real aim of scientific work, which is to seek the truth, believing that the gifts of science hold potential good. K.C.C.

ANTHROPOLOGY.

President: PROF. V. G. CHILDE.

THE ORIENT AND EUROPE.

PROF. V. G. CHILDE, in his Presidential Address in the Anthropology Section before the last meeting of the British Association, upheld the claims of Pre-history as an experimental science based upon solid facts like "relics and monuments". Comparing the Oriental culture with European Prof. Childe supported the axioms propounded by Montelius in 1899. He described in detail the recent excavations in the Near East specially that of the German school at Erech and of Mallowan and Speiser in Syria and Assyria. Prof. Childe puts the date of the Erech finds at 4500 B.C. roughly, while that of the earliest stratum at al' Ubaid at the sixth millennium B.C. The Anatolian chalcolithic is assigned to fourth millennium B.C. The earliest cultures of the Fertile Crescent aré so unlike anything known in Europe "as to seem incommensurable", but Heurttley's excavations in Macedonia have established connections between Asia and Europe and the Anatolian ancestry of the Early Macedonian Bronze Age cannot now be denied. The Macedonian relics can be well compared with the Vardar-Moravian culture of the Danube Basin and a cultural continuum between the Aegean Coasts and the Danube Basin seems to be likely.

Referring to Banner's researches in Hungary and Butler's investigation in Germany, Prof. Childe said that they had no counterpart in the Orient. The earliest bronze objects of Europe are associated with the Aunjetitz culture which can be traced back to 3000 B.C. in the Orient. The earliest neolithic culture of Europe is revealed by Danubian I, but in the Orient the finds of early settled cultivated life below the Tel Halaf village appear to be more advanced than that of the ancient Danubians. Objective proofs of cultural continuity between the Near East and Central Europe by diffusion are yet wanting and is much to be expected from the Balkan regions which is unexplored.

S. SARKAR.

PSYCHOLOGY.

President: DR. R. H. THOULESS, M.A., PH.D.

EYE AND BRAIN AS FACTORS IN VISUAL PERCEPTION.

LIGHT ON THE PSYCHOLOGY OF VISUAL PERCEPTION.

DELIVERING the Presidential Address of the Psychology Section of the British Association for the Advancement of Science held recently at Cambridge, Dr. Thouless, M.A., Ph.D., has undertaken a survey and critical assessment of the psychological value or significance of the part played by the EYE and the BRAIN in visual perception. Not merely the sensitive retinal surface and the "Visual areas of the cortex", but, the "Whole system which includes retina, optic nerve, visual area of the cerebral cortex, and other sensory areas of the brain as well" would appear to constitute the physiological mechanism of vision.

In the first section of his presidential pronouncement, Dr. Thouless briefly states and examines the "Transmission Theory of Vision" which had enjoyed the support of such eminent investigators as Helmholtz, and which while over-emphasizing the importance of the activity of the retina, seeks to neglect or to relegate to a secondary position other factors. The Transmission Theory notwithstanding influential backing at the hands of the expert as well as the man-in-the-street, should be deemed defective. In the second section, "Experimental Objections to the Transmission Theory" are recorded. Sometimes differences in visual perception as in the case of yellow and red are due to difference in the bands of wave-lengths, of light and at other times the difference between perception of red-book and red-patch of the spectrum is due to no such difference. The adoption of the "Phenomenological" standpoint by psychologists paved the way for correct experimental approach to a study of vision in all instances whether or not accompanied by differences in local physiological stimulation. The main attack on the "Transmission Theory" came from Wertheimer (1912) who investigated the so-called "Phi-movement". Dr. Thouless suggests a simple experiment the apparatus being just an oval table-mat, or a sheet of cardboard and a pair of scissors. After setting forth three objections against the Transmission Theory, Dr. Thouless concludes reinforcing the view of Wertheimer that the "Sensation" corresponding to the conditions of local retinal stimulation as an element in a complex perception is a mere fiction. In the third section, "the whole case against the Transmission Theory" is presented. Offering an alternative explanation, Dr. Thouless suggests that the mind, or the brain acting to some extent as a unitary whole is active in perception responding to information given by the sense organs and not merely reproducing a pattern of stimulation from the sense-organs. Thus, the visual characteristic of an object should be understood or interpreted as the product of combined action of different activities of the visual cortex which also make their contributions to the other characteristics of the perceptual field. In the fourth section, Dr. Thouless examines "Individual Differences in Visual Perception", and points out that phenomena "are determined not only by the local stimuli but also by the perceived real characters of the objects causing the stimulus". In interpreting individual differences in visual perception, Dr. Thouless would like to speak of "Phenomenal regression" (in preference to constancy tendency as some have it) in respect of shape, size and colour. Is the phenomenal regression governed by any laws? Not necessarily fool-proof laws though. Notwithstanding individual differences, regularities are to be found. Dr. Thouless finds that the

tendency to see the real characters of objects *increases through life* being least with young children. Dr. Thouless suggests a hypothesis which seeks to do justice to the claims of both the so-called "Nativists" and "Empiricists". The tendency to phenomenal regression is congenital endowment but individual differences and idiosyncracies are the result of experience. What are the practical consequences of a theory of visual perception? The concluding (fifth) section is devoted to an elucidation of the practical consequences that flow from the theory advanced. For instance, a person with high phenomenal regression can drive a car better in traffic, phenomenal regression revealing a correlation with efficiency or ability to drive. Dr. Thouless takes stock of the situation in the concluding paragraph. Vision is not a function of the eye alone. Higher centres actively co-operate in vision. Mere sensory physiology of the eye is hardly a substitute for genuine psychology of visual perception.

Let me add only a very brief comment. The YOGA system of Indian Experimental Psychology has advanced the claim that *extra-sensory perception is perfectly practical politics*. Dr. Rhine's volume on E. S. P. has almost created a revolution in Psychology. Though Dr. Thouless makes no mention of it in his address, examination of the claims of E. S. P. must be boldly and courageously undertaken within the jurisdiction of laboratory discipline.

R. NAGA RAJA SARMA.

BOTANY.

President: PROF. W. STILES, F.R.S.

THE GENERAL PHYSIOLOGY OF THE PLANT CELL AND ITS IMPORTANCE IN PURE AND APPLIED BOTANY.

AFTER tracing briefly the history of development of Cell physiology, Professor Stiles classified investigations in general Cell physiology into four groups, namely "(1) those concerned with the chemical and physical constitution of the protoplasm and other cell constituents; (2) the study of enzyme action; (3) those dealing with absorption and excretion of water and dissolved substances which have, for the sake of convenience, generally in the past been referred to as problems of cell permeability; and (4) those concerned with respiration. The first two are largely biochemical studies, and it is with the more purely physiological problems of respiration and salt and water relations that I propose mainly to deal in this address." Although investigations into these various aspects of vital activity have developed to a large extent independently, they are closely connected. Thus, for example, passage of water into and out of the cell, absorption of dissolved substances by the vacuolated cell, and enzyme action and respiration are all functions of protoplasm. As to the nature of protoplasm itself, Professor Stiles said, "At present, then, we must be content with recognising in the protoplasm a system in which an essential feature is the possession of a large internal surface, with all that this involves, in which there are various phases of different chemical composition, a composition roughly but by no mens accurately known. One of the characteristics of this system is that, in so far as it can be regarded as a system in equilibrium, it is in a state of dynamic, not static equilibrium, for all the time it is absorbing oxygen and giving out carbon dioxide."

After a detailed examination of work on respiration of normal plants and succulents, he says, "While then data are accumulating which indicate the linkage of anabolic process with those of the breakdown of sugar, it is important to note that there is no evidence of the formation of products other than carbohydrates. Is it possible, however, that syntheses of more complex substances are indeed involved, and that we have here a dim glimpse of the mechanism for the production of these substances, and that along with the formation of sugar or some intermediate there may be also the formation of protein or other complex substances; that, indeed, we have here the mechanism by which the carbohydrate is brought into a suitable form for combination with nitrogenous and other compounds?"

Professor Stiles then proceeded to examine in detail the relation of respiration to absorption of electrolytes and comes to the conclusion that the relationship of respiration to the absorption of salts by plant cells, *viz.*, the accumulation of salt depends on the vitality of the cells and that the maintenance of this vitality depends, as has been long recognised, on the presence of oxygen, either because aerobic respiration or some other process requiring oxygen is essential for this maintenance of vitality, or because in the absence of oxygen the accumulation of carbon dioxide and other products of anaerobic respiration adversely affects the functioning of the protoplasm.

The fundamental importance of the principles of general Cell physiology in plant metabolism is next emphasised. The process of photosynthesis, the passage of the products of photosynthesis from the assimilating cells to the phlœm and related phenomena are all based on the principles of Cell physiology in as much as they depend on the activity of specialised cells and tissues. Even ecological studies, especially the higher branch, *i.e.*, the detailed investigation of the functional relations of plant associations to their surroundings are based on such principles.

Professor Stiles concludes, "With the ever-increasing mass of knowledge in the various branches of botany, an increase which is especially noticeable to-day in those aspects of our subject which are undergoing rapid development, physiology, mycology and genetics with cytology, it is impossible for any one to be an active worker in more than a relatively very small field of botanical endeavour. We sometimes meet with reference to a mysterious gentleman called the 'general botanist' who is expert in general botany, as someone distinct from the morphologist, physiologist, mycologist or other worker in a defined field. But in these days, when to make any contribution to knowledge necessitates

specialisation, there can indeed be no such person as the expert in 'general botany', for there is, indeed, no such subject. But in whatever part of our subject our own special interests may lie, we can still appreciate the efforts and aims of workers in other fields, and realise the bearing of work in these fields on our own problems, and in this sense, we are all general botanists, that is, just botanists.

"For if 'general botany' as something distinct from 'botany' is a myth, there is no doubt that the various branches of our subject are related in the whole. In this address I have tried to indicate not only the scope and present position of our knowledge of the general physiology of the cell, but where this particular part of the science or of plants comes into contact with other branches of botany, and how the application of a knowledge of the facts, principles and methods of Cell physiology may be expected to lead to an increase in knowledge, not only of the physiology of the plant, but of other aspects of botanical science and of its industrial applications."

P.P.

EDUCATIONAL SCIENCE.

President: MR. J. SARGENT.

THE FUNCTION OF ADMINISTRATION IN PUBLIC EDUCATION.

MR. J. SARGENT delivered the Presidential Address on the 'Function of Administration in Public Education' to the Educational Science Section of the British Association for the Advancement of Science. According to him the Educational Science comprehends not only the philosophical principles upon which the educational practice is based, but also experiment and research into method and as such the subject deserves inspection by the Educational Scientist. In so examining the question, he dwelt at length on the administrative machinery, namely, Local Education Authority, and described the function of Administration as a method of transacting public business, cheaply and quickly. Administration expresses itself through two functions—the Legislative and the Executive, and the Local Education Authority is virtually the Executive and Central Government being Legislative wholly.

By a process which is at once historical and natural, the legislative side of administrative activity has remained largely in the hands of Central Government, though it would be to fall into an error which professed experts have not always avoided, if the fact were overlooked that in many instances experiments legitimately conducted by local authorities within the powers conferred upon them by Acts of Parliament have often led to new ideas and consequent legislation.

The gradual change in the conception of the function of the State in relation to the individual citizen which has marked the last century and with increasing emphasis, the last quarter of it, has resulted in a vastly increased interference by the State in the goings and comings of the ordinary citizen.

The growth in this business of Government, as in other business, has forced home the need for administrative devolution, with the consequent rise of local government as the machinery through which much of the will of Parliament must be implemented.

There is one aspect of this relationship, however, which is important, and that is the financial one. On the wider issue we may rest content with the fact that, whatever arguments may be adduced or principles invoked, so long as there are local administrators they will continue to pursue the laudable object of getting as much money and as little interference from the central authority as they possibly can. All the difficulties seem to arise from the present nature of the Local Government bodies themselves. The first difficulty would appear to lie in the unit, *i.e.*, in the size and geographical distribution of Local Government.

Apart from the questions of size and population, Local Education Authorities also vary greatly in their financial resources as regards both their own rateable value and the contribution which they receive from the Exchequer towards their net expenditure. In fact, the whole question of the financial relationship between the Central Government and the Local Government is one which calls for an immediate and comprehensive review.

Then again Authorities vary very much in their character, some being purely rural, many purely urban, while others contain a mixture of the two or are in process of transition from the former to the latter.

It is true that many of these difficulties can be and are in fact being overcome by co-operation between the authorities concerned, but it should be pointed out that while co-operation ranks high among the blessed words in the educational vocabulary, it usually involves a compromise and is never the ideal method of administrative procedure.

The next problem is concerned with the personnel of the Local Education Authorities. The personnel is divided into the amateur and the professional elements, or the unpaid and the underpaid as frequently expressed. The amateur element is again divided between persons co-opted for their knowledge of and interest in education, and others elected by the people not solely, because they are known to possess either or both of these qualifications.

The most serious aspect of the problem is the steady and even accelerating deterioration in the amateur personnel which has taken place since the War. This is particularly marked in the case of the elected representatives of the people. Consequently local administration is being progressively denuded of persons actively engaged occupying positions of responsibility in industry and commerce.

There seems no sign whatever that either of these tendencies is likely to lose its effect. Everything in fact points in the other direction and the result is already apparent in the increasing tendency of Education Authorities to consist of people who have retired from work or have

never had work, or who are in fact professionals rather than amateurs because, as officials of political or other associations it is expedient for them to become members of local education authorities from the point of view of promoting the objects which their associations have at heart.

There is, however, a risk, which is more than theoretical, of intellectual dishonesty creeping into the discussion of educational affairs when the Authority contains any substantial number of members who are pledged to a set of opinions which may have a cross-bearing on purely educational consideration.

SUGGESTIONS.

It is, however, possible, for practical experience and even *a priori* reasoning to suggest certain of the attributes which the ideal Local Government unit should possess.

(1) The administrative unit should be large enough to be able to provide the variety of services which a modern community requires, but not so large that the day-to-day discharge of routine administration necessitates a rigid or bureaucratic attitude towards the problems presented for solution.

(2) From the economic point of view the authority should be sufficiently large to be able to obtain good contracts for the supply of the various materials which it requires. When this stage is reached the question of devolution becomes just as important as that of centralisation at the early stage.

(3) The redistribution of areas in a manner that none of them may in future be exclusively rural or exclusively urban, is another important matter in this connection. This is a proposition which has commended itself widely to many social reformers who have advocated a regional organisation for Local Government.

(4) To some extent the establishment of geographical units of a more uniform and rational size would contribute towards the solution of the major difficulty of personnel because while it is true that some small authorities enjoy admirable committees and officials, some of the larger ones are notoriously below standard in these respects.

Unless people who are competent to govern can be made to realise that the preservation of liberty must depend on the capacity of those who voluntarily serve the community, that is, unless people are moved in greater numbers to offer themselves for public service by the Socratic urge, namely, fear of being governed by worse people than themselves, the prospect of arresting the deterioration in the amateur personnel of local authorities is small.

Local Government will have in future to counteract the deterioration in its amateur element by a corresponding improvement in the professional element, that is, it will have to look to recruiting better officials in the future than it has recruited in the past. This is not simply a matter of higher salaries, it is more a question of placing the training and status of the Local Government officer on a basis at least equal to that of the central civil servant. Speaking in mundane terms, the educational administrator should have had a University training and some experience as a teacher in one branch or other of the education service. It is essential that he should possess the qualities of a sound administrator, that he should know how to initiate, when to delegate, when and where to advance, how to endure setbacks—above all, how to handle men.

Finally he must beware of the hardening effects of custom and precedent. The needs of society are changing rapidly and it is the function of all educators to study these needs and consider how best they can be met. At its highest this demands from him a philosophy of life in which he is compelled to study continually the philosophical basis of education and the principle on which this great human science has developed; at the worst he falls back on Pope for comfort and inspiration

"Whatever is best administered is best."

K.R.R.

AGRICULTURE.

President: PROF. R. G. STAPLEDON, C.B.E., M.A.

LEY-FARMING AND A LONG-TERM AGRICULTURAL POLICY.

PROFESSOR STAPLEDON has rendered a real service by calling attention to certain defects in the prevailing agricultural practices and the importance of ley-farming or rotation farming in any rational long-range agricultural policy. A ley is land sown with grass for a short period of one to two or more years due to be ploughed up at the end of the definite period in rotation with other crops. He advocates three basic principles as fundamental to such a long-range policy; firstly, the maintenance of as large and contented a rural population as possible as the basis for increase of total population; secondly, maintenance of the largest possible acreage in a highly fertile and always ploughable condition; and thirdly, farming methods which permit of the maximum flexibility in commodity production. He accordingly evaluates farming systems from the criteria of their flexibility for commodity production, supply of feeding stuffs, the maximum needs of the soil for the maintenance and enhancement of its fertility and the amount of labour involved. Professor Stapledon is a strong advocate of ley-farming or alternate farming which secures the harmonious combination of animal and crop-husbandry. He condemns permanent grass farms as they contribute nothing more valuable than inferior hay to the winter ration and contain the minimum acreage in a ploughable condition and necessitate the largest dependence on imported feeding stuffs. He also condemns the non-descript farms which have permanent grass-lands with no rotation. Arable farming whose chief object is the production of cash crops such as market gardening errs at the other end in being dependent on extraneous sources for farm and stable-manure

necessary for soil-fertility. He recommends as important from the point of view of national welfare the arable-grass or grass-arable rotation. This system of periodical rotation between grass and crops is highly commended by him as farming which has reasonable demand for labour which is less dependent on imported sources for feeding stuffs and maintains the acreage and the farmer in a condition of maximum flexibility for commodity production. The rotational grass-lands (leys) are better managed than permanent grass-lands. Permanent grass-lands harbour the organisms of disease, deplete the soil of lime and are not well-suited for grass silage. Permanent grass makes the land weedy, and has a shorter growing season and yields less grass than leys. The ley further more affords great scope for special treatment so as to provide grass when most wanted.

Regarding the question as to the best course in ley-farming Prof. Stapledon recommends 1 to 2 year deep-rooting hay leys and 4 to 6 year leys for grazing only. He concludes with the suggestion to conduct a survey of the farms and farmsteads for suggesting the ways and means of bringing grass-lands under the plough. Prosperity in agriculture is a function of working capital for equipment. To this end Prof. Stapledon recommends the American idea of group loans, a master-borrower being given a tractor and necessary equipment to plough up the derelict grass-lands. Any well-wisher of agriculture cannot be too grateful for the well-considered ideas of Prof. Stapledon for improving the efficiency of farming to promote individual and national welfare. T.G.R.

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES.

President: Rt. Hon. The Earl of Onslow, G.B.E., P.C.

THE IMPORTANCE OF NATIONAL PARKS IN THE PRESERVATION OF THE FAUNA OF GREAT BRITAIN.

THE President has rightly tackled a subject which demands special attention by reason of its unlimited educational, scientific, economic and national value. The Earl, at the very outset, defines what is meant by a "National Park considered internationally".

Thus the expression "National Park", "shall denote an area (*a*) placed under public control, the boundaries of which shall not be altered or any portion be capable of alienation except by the competent legislative authority, (*b*) set aside for the propagation, protection and preservation of wild animal life and wild vegetation, and for the preservation of objects of æsthetic, geological, prehistoric, historical, archæological, or other scientific interests for the benefit, advantage and, enjoyment of the general public, (*c*) in which the hunting, killing or capturing of fauna and the destruction or collection of flora is prohibited except by or under the direction or control of the Park authorities."

"In accordance with the above provisions facilities shall, so far as possible, be given to the general public for observing the fauna and flora in national parks."

"The term 'strict natural reserve' shall denote an area placed under public control, throughout which any form of hunting or fishing, any undertakings connected with forestry, agriculture, or mining, any excavations or prospecting, drilling, levelling of the ground, or construction, any work involving the alteration of the configuration of the soil or the character of the vegetation, any act likely to harm or disturb the fauna or flora, and the introduction of any species of fauna and flora, whether indigenous, or imported, wild or domesticated, shall be strictly forbidden; which it shall be forbidden to enter, traverse, or camp in without a special written permit from the competent authorities; and in which scientific investigations may only be undertaken by permission of those authorities."

"You will see that not only do the African Powers contemplate the creation of National Parks but also of another type of reserve which they denominate a strict natural reserve. This was put in at the instance of the French Government who were anxious to provide for the creation of areas for the preservation of fauna and flora to which the public should not have access except under very definite restrictions; that is to say, they were to be created for purely scientific purposes, while the National Parks are to afford as much access to the general public as is possible compatible with their reasons for existence. Now in England we are apt to be rather more loose in our terminology and National Parks cover a very wide field—in fact, they cover any natural reserve or open space to which the public have access regardless as to whether they are to be devoted to the species of fauna and flora or not, and to-day I propose to devote myself to the methods of utilising the National Parks of this country on the lines contemplated in the African convention. I may say that there are a number of National Parks throughout the world devoted to fauna preservation. In Africa, for example, there are the Parc National Albert in the Belgian Congo and the Kruger National Park in South Africa. The success that has attended the creation of these parks might, I think, tempt us to try and do something of this kind in this country."

The President refers to the policy of the Committee which has already been formed in England. According to this Committee the Government should:

(*a*) Declare that the establishment of National Parks is an essential national service.

(*b*) Set up, as chief and central agents, two National Parks Commissions (one for England

and Wales and one for Scotland, with a joint committee co-ordinating the two).

(*c*) Provide funds.

Co-operation of the various learned Societies in England has also been offered as they are all keenly interested in the matter. The Earl then discussed the suitability of a place in Great Britain for the establishment of a "National Park", and mentioned the various species of animals which might form very suitable inhabitants of the proposed National Park in Great Britain.

As regards financing such an establishment "People are apt to be frightened at the cost of buying a large area of land and maintaining it, but in the first place private individuals acquire deer forests and what is possible for a private individual should not be impossible for the public generally either under the Government or by means of public subscription. It would be costly but not necessarily ruinous."

"Then as regards maintenance, in the first place there would be an income coming in as there is in the National Kruger Park, which makes quite a handsome income. There would have to be, of course, an hotel or rest-house or something of that kind, and roads and foot-paths would have to be made so that people could get about and see the animals. A number of keepers would be required corresponding with the stalkers on a forest, probably rather less than a forest needs. But there would not have to be nearly as many ghillies, pony men, dog men and so forth. A few to act as watchers and keep off poachers and a few to keep sightseers from disturbing the sanctuary would be all that is necessary. Indeed, I do not believe that the number of people employed would be as great as in a forest, so that I do not think we need be unduly terrified either by the cost of acquisition or of management."

"And now I come to the last point, namely the method of management, and here I would like to refer you to the ideas which have been put forward by Sir Peter Chalmers Mitchell."

"He advocates a scheme whereby the arrangements for the popular functions of a National Park would be entrusted to delegates appointed by Edinburgh, Glasgow, Dundee and Aberdeen, working with delegates appointed by the Council or Councils of the county or counties in which the Park was situated. He would add to the Governing Body of the National Park a panel of persons selected for their special knowledge of wild nature in all its aspects, at least one botanist, one zoologist, one geologist, and two 'field naturalists', one with special knowledge of plants, the other an ornithologist. He thinks these might be selected by the Principals of the four Universities, the President of the Royal Society of Edinburgh, and of the Highland and Agricultural Society. Moreover, apart from the staff concerned with the general regulation of the Park, there should be one warden or ranger selected by the Naturalist panel, whose sole duty should be the constant study of wild life in the Park and all its fluctuations."

The scheme put forward by the President of the British Association deserves particular attention to the people of this country. In India establishment of several National Parks in suitable places in the various provinces will be required in consideration of her rich and great variety of fauna and flora. It is well known to biologists that there is a close association between floristic and faunistic composition. Therefore in a National Park not only the fauna (on which more stress has been laid by the Earl) but also the flora should play an equally important part. The Government and the public in this country also are aware of the importance of preserving our indigenous fauna and flora. Steps, I infer, have already been taken in the previous forest reserves in this country to effect a better control for the preservation of the wild plants and animals. In any case a strong representative Committee, as suggested by the Earl, consisting of experts from the Government Departments, Universities, Societies and Clubs in India should be formed to establish National Parks in this country in a proper form. With the support of the public, aid of the Government and munificence of our generous and farsighted princes and the nobilities, the difficult question of finance can be solved. Young India must not lag behind in this aspect of biological advancement of the country.

K.B.

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